THE IMPLEMENTATION OF STEM-BASED LEARNING ON MATTER PRESSURE TO IMPROVE MOTIVATION AND STUDENTS LEARNING OUTCOMES

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Abstract

The purpose of this research is to describe the motivation and student learning outcomes after implementing STEM-based learning. This type of the research is Pre experimental design and uses the One group pretest-posttest research design. The research was conducted at SMPN 17 Surabaya in class VIII-A and VIII-B. Increased motivation and student learning outcomes were analyzed using the N-Gain Score test. Student learning motivation has increased after STEM-based learning with an average N-Gain of 0.6 in each class with a medium category. Student learning outcomes have increased in each class and the N-Gain score is 0.7 with a high category. Based on these data it is stated that there is a consistent increase in student motivation and students learning outcomes after STEM-based learning is applied.

Keywords: STEM, Motivation, Student learning outcomes.

INTRODUCTION

The development of the 21st century is a challenge in all circles, especially in the fields of science and technology. 21st century skills according to the partnership for 21st century skills consist of: 1) learning and innovation skills, 2) information, media, and technology skills, 3) life and carrier skills (Trilling & Fadel, 2009). Based on the Minister of Education and Culture number 22 of 2016 explained that school learning activities should be carried out interactively, pleasantly, inspiringly, and be able to encourage students to take part in learning activities, besides that they also have to give students the opportunity to show their creativity and independence in learning activities. This expectation can be realized by optimizing learning to become a new atmosphere in order to increase interaction and motivation learning.

Learning activities can be successful if students have motivation in learning, teachers should increase student motivation by teaching creatively (Martanto, 2010). Based on the description from the United States Agency for International Development (USAID): (Decentralized Basic Education 3) Life Skills for Youth (DBE3), teachers can apply several ways to build student learning motivation, those are: 1) giving assignments to students. The assignment should be challenging but realistic and in accordance with the material it means that the assignments given to students have to be weighted. It makes students more motivated in completing them, but do not make it difficult for students ,so students do not easily fail in assignments, students will be always motivied, 2) using diverse learning methods, 3) active participants, 4) creating a conducive classroom atmosphere, it can make students feel comfortable in learning, 5) providing proportional assignments, 6) teachers involve themselves in assisting students achieving results, 7) teachers provide guidance for students to achieve in completing tasks, 8) the teacher tries to keep the students away from the competition between them, 9) the teacher always gives input on what the students are doing, 10) appreciating the success of the students, 11) the teacher have to be enthusiastic in teaching so that students do not feel bored, and 12) giving appreciation and motivation to students (Sanjaya, 2009) .

Increasing the education quality can be seen from the learning both in the process of motivation and student learning outcomes. Student motivation increases not only judged by student involvement in learning activities but also how they understand information obtained during the process of learning activities. Students who are motivated in learning activities will be able to use their cognitive processes and master the material well (Nur, 2001).

According to the PISA survey, 15-year-old students in Indonesia have low rank in mathematics and science subject. It is still dominated by China, Korea, Singapore, Finland, Taiwan and Switzerland. Therefore, STEM-based learning needs to be developed in Indonesia because STEM learning integrates four disciplines konwladge at once, there are science, technology, engineering, mathematics. (Organization for Economic Cooperation and Development, 2015).

Based on the results of the interviews with class VIII A at Junior High School of 17 Surabaya stated that students are less interested in science because they feel

that science is one of the bored learning, science has most formulas and there are many lessons should be memorized, students also rarely do lab work and make a project. This is also supported by the results of interviews with one of the science teachers who is teaching in this school. He explained that the learning carried out was still using direct instruction method and discussion method because of the limited tools and different character of the students, besides that he also stated that the lesson that calculates using the formula he got some problems when learning, one of the problem is students do not understand the basic mathematical concepts. He also explained that students will be more interested in participating science learning if teacher connect the lessons in daily life and they also saw the tools and practiced directly. Based on the value of students in the Basic Competence 3.8 class VIII A which consist of 38 students have scores below the Minimum Completion Criteria were 73.69%, this also happens in class VIII B which consist of 38 students have scored below the Minimum Completion Criteria were 71 , 05% with the Minimum Completion Criteria of 75.

Based on the Minister of Education and Culture number 20 of 2016 explained that education graduates have to have competence in the knowledge dimension, namely the factual dimension that refers to simple technical and specific level of knowledge related to the field of science and technology. Therefore, project-based learning or STEM is needed. Hopefully students are more motivated in conducting learning activities. STEM-based learning at this time has also been applied in various countries to overcome the problem of human resources and face global competition (Rahayu, 2017).

Basic competency 3.8 is to understand the matter pressure and its application in daily life including blood pressure, osmosis, and capillary transport network in plants is the material contained in grade 8 in the second semester. This material needs to be taught by applying STEM-based learning models. Implementing STEM-based learning model is important, because there is a higher demand for workers in these fields to improve the economy in the country. Researchers agree that schools are a suitable place to develop students' careers that are in accordance with their interests, one of the ways is by involving students in scientific skills, knowledge of science content, and motivation for STEM careers (Hiller and Kitsantas 2014).

Based on research conducted by researchers that is related to STEM learning are (1) Micah Stolhman (2012) shows the results of students taught by teachers who have background in technology, mathematics, and engineering had better understanding of the material, (2) Xianglei Chen (2009) get the results of 53% of students who come from schools by implementing STEM have the ability in the fields of science, technology, engineering, and mathematics superior to schools that do not apply STEM, (3) Rahmiza (2015) shows results using X^2 count test > X^2 table is (7.81) on learning motivation while student activity shows a value of 24.9 > 5.99, it can be concluded that STEM-based student worksheets can increase student motivation and learning activities.

Research conducted by Rahayu (2017) using STEM-based learning devices at Arroudhoh Plus Middle School in grade 8 with a total of 48 students in matter pressure material was able to train students' creative thinking skills where the results obtained validly developed learning devices based on validation carried out by experts, the implementation of the lesson plan is in accordance with the stages of guided inquiry learning and the devices developed are effectively used, this is proven by the results of students' thinking skills after being tested in the creative category with an average value of 85.5, and student responses to the device are very positive. This research needs to be followed up for different subjects and schools to increase student motivation and learning outcomes.

Based on the background, the researcher conducted a research under the title "The Implimentation of STEM-Based Learning in Matter Pressure Material to Increase Student Motivation and Student Learning Outcomes".

METHODS

The type of research is pre-experimental design. The study was designed using One Group Pretest-Posttest, with a pattern in Figure below.

O1	**X**	**O2**

Figure 1. Design of One Group Pretest-Posttest Design.

Note:
O1 = initial test (pretest)
O2 = final test (posttest)
X = treatment

The target of the research was students of Junior High School of 17 Surabaya in class VIII-A and VIII-B which consist of 75 students. Data collection techniques in this research were used questionnaires and tests. The questionnaire were used to the ARCS model motivation questionnaire. Tests are conducted to determine student learning outcomes, this test is carried out before (pretest) and after (posttest) STEM-based learning is applied. The research instrument consisted of the pretest

and posttest questions and the ARCS motivation questionnaire by Keller (1998).

The questionnaire results were analyzed using the ARCS model by Jhon Keller and analyzed by paired t-test using SPSS 16 and N-Gain Score to determine the increase in student motivation. The results of the pretest and posttest test questions were analyzed by t-test paired using SPSS 16 and N-Gain Score to determine the improvement in learning outcomes (Hake, 1999).

RESULTS

STEM-based learning activities have done for three meetings. The material that was taught are solids pressure, liquids pressure and gases pressure. The learning activities besed on the lesson plan that has been made by using guided inquiry learning methods.

The first meeting discussed about the solids pressure. In this meeting, students solved a problem how the effect of the base area on the depth of the trace. Students assemble a practicum tool by making a plasticine side that has a different base area and dropping on flour with the same height, then calculating the difference depth of the plasticine trace. The designation of STEM-based learning at the first meeting used the SILO approach. In this study only aspects of science and mathematics are applied.

The second meeting discussed the liquid pressure. Students made simple elevator that use Pascal law principle. A simple hydraulic elevator serves to move loads at different heights. The load used has a different mass. This learning uses an embedded approach, there are aspects of science, technology, engineering, and mathematics.

The third meeting, students made a tool namely a simple water manometer. Students are asked to calculate the amount of air pressure using the water manometer they made. This learning using embedded approaches includes aspects of science, technology, engineering, and mathematics.

The highest student enthusiasm is when students design tools. It is proven by observations student activities. It can be seen in the table below.

Table 1. The Percentage of Students, activities in designing tools

	1st Meeting	2nd Meeting	3rd Meeting
VIII-A	35%	47%	47%
VIII-B	46%	52%	49%

The percentage of students' activities in designing tools in class VIII-A obtained 35%, 47%, and 47%, while in class VIII-B obtained a percentage of 46%, 52%, 49% in each meeting.

Based on the results of the research, it increased motivation and student learning outcomes. Student learning motivation is obtained from student motivation questionnaires given before STEM-based learning activities and after STEM-based learning activities. Learning outcomes are obtained from the pretest and posttest values.

Increased student learning motivation is given at the beginning before learning and at the end of learning activities. Motivation measurements were measured using the ARCS questionnaire developed by Keller (1998), the questionnaire was developed by researchers on the basis of advice from the supervisor.

The learning students' motivation in class VIII-A is increase before STEM-based learning and after STEM-based learning. Before STEM-based activities were carried out, it got an average percentage of 51%, while after STEM-based learning the percentage of students' learning motivation increased to 80%. The t-test by using SPSS 16 showed a significance value of 0,000, based on Trihendradi (2009) the results showed that H_0 was rejected and H_1 was accepted, it means there was a difference before and after treatment. The average N-Gain results is 0.6 with the medium category. The increase in the average percentage of student learning motivation also occurs in class VIII-B where the percentage before STEM-based learning activities got an average percentage of 47% to 82%, The t-test by using SPSS 16 showed a significance value of 0,000, based on Trihendradi (2009) the results showed that H_0 was rejected and H_1 was accepted, it means that there was a difference before and after treatment. The average N-Gain results is 0.6 with the medium category. The existence of the same N-Gain category in both classes can be proven that there is a constant increase in student motivation in both classes. Based on the explanation from Mitarlis, et al (2009) science learning has purpose to improve the efficiency and effectiveness of learning, increase interest and motivation, and achieve several basic competencies at once, by implementing STEM-based learning can improve student' learning motivation.

The motivation aspect of learning from Keller (1998) consists of several indicators including attention, relevance, confidence, and satisfaction. Motivation questionnaires were given before and after STEM-based learning activities were carried out in both classes. Increasing each aspect of motivation can be seen in the Table below.

Table 2. Increased Motivation for Each Aspect of Class VIII-A

Indicator of ARCS	Before %	After %	N-Gain	Category
Attention	52	78	0.5	Medium
Relevance	54	81	0.6	Medium
Confidence	47	81	0.6	Medium
Satisfaction	51	79	0.6	Medium

The percentage of each aspect motivation can be seen in this table below.

Table 3. Increased Motivation for Each Aspect of Class VIII-B

Indicator of ARCS	Before %	After %	N-Gain	Category
Attention	43	78	0.6	Medium
Relevance	48	82	0.7	Medium
Confidence	45	81	0.6	Medium
Satisfaction	46	79	0.6	Medium

Increased student motivation is supported by the students' activity in STEM-based learning activities. Indicators of attention motivation according to Keller (1998) can be grown by stimulating students' curiosity or providing problems have to be solved by them. In this case the activity of students' accordance with these indicators are to observe authentic problems and formulate problems and make hypotheses. It can be seen in the table below.

Table 4. Percentage of Students' Activities in observing problem

	1st Meeting	2nd Meeting	3rd Meeting
VIII-A	11%	6%	7%
VIII-B	6%	5%	8%

The percentage op students' activities in making hypothesis can be seen in the table below.

Table 5. Percentage of Students, Activities in making hypothesis

	1st Meeting	2nd Meeting	3rd Meeting
VIII-A	12%	9%	8%
VIII-B	8%	9%	9%

The average percentage of observing problems in class VIII-A from the first to third meetings are 11%, 6%, and 7%, while in the activity of formulating problems, and making hypotheses have a percentage of 12%, 9 %, and 8%, in class VIII-B in the problem formulation activity there are consecutive percentages of 6%, 5%, and 8%, while making hypotheses obtain successive percentages of 8%, 9%, and 9%. This is accordance with the results of the percentage motivation aspects of attention that is equal to 78% in class VIII-A and 78% in class VIII-B, this activity does not dominate.

The most dominant student activity is designing tools and conducting experiments and analyzing the experiments' results, these activities include indicators of convidance and relevance. According to Keller (1998) student' confidence can be seen if they believe that they will understand the lesson well, so they actively participate in learning activities. The relevance indicator according to Keller (1988) can be done by the way students consider that the study is releven with themselves. The percentage designing tools can be seen in the Table 1. The percentage of activities students' in analizing data can be seen in the table below.

Table 6. The percentage of Students' Activities in Analizing Data

	1st Meeting	2nd Meeting	3rd Meeting
VIII-A	19%	17%	20%
VIII-B	22%	17%	17%

The activities of students designing tools in class VIII-A got an average percentage of 35%, 47%, and 47% respectively, and analyzing the data got an average percentage of 19%, 17%, 20%. In class VIII-B the activity of designing a tool gets a percentage of 46%, 52%, 49%, analyzing the data gets an average percentage of 22%, 17%, and 17% respectively. This is accordance with the motivation on the relevance and confidance indicators. They get the highest percentage after STEM-based learning. a percentage of 81% and the confidence aspect scores 81% in class VIII-A and in class VIII-B that is 82%, while confidence aspect gets score of 81%, the percentage of these aspects were the highest percentage among the other aspects of ARCS motivation, it was related with the results of the activities of the most dominate.

The indicator satisfaction according to Keller (1988) the indicator can be done by providing stimulus, feedback, and reinforcement to students. Based on the activity of making conclusions and conducting discussions, the percentage of student activities in class VIII-A and VIII-B was lower than designing tools, the percentage in this aspect was 79% in each class.

Based on research conducted by Ridwan and Rahma (2018) also showed the same results. The study was conducted on Junior High School which consist of 25 people. The results is some students get very high learning motivation, 68% of students got high motivation, and 8% got moderate motivation.

Based on the result of this research by implementing STEM-based learning on cognitive aspects, the learning outcomes can be seen from the comparison of the values of pretest and posttest in both classes with Minimum Completion Criteria of ≥75 for science lessons and improving learning outcomes

calculated by the N-Gain formula. Student learning outcomes is gotten by giving pretest and posttest questions. Pretest is used to determine the initial value of students, while posttest is used to determine the final value of students by applying STEM-based learning.

The pretest values in class VIII-A and VIII-B got an average value of 42.1 for class VIII-A and 40.8 for class VIII-B, from that test no students were declared complete and got the Minimum Completion Criteria value. It has been determined in these two classes, because students have not received material for the subject before, but when they do posttest there is an increase in the value of the students. The t test by using SPSS 16 obtained a significance value of 0,000, based on Trihendradi (2009) the results showed that H_0 was rejected and H_1 was accepted, it means that there was a difference after treatment. These results occur in both classes. The description of N-Gain in class VIII-A gets the average score is 83.3, an average value of N-Gain 0.7, and get a high category. in class VIII-B gets an average score of 82.7, an average N-Gain of 0.7, and get a high category. Based on the results of the N-Gain value of students in every class have the same average N-Gain which is equal to 0.7 with a high category, it means that in both classes there is a consistent increase in learning outcomes. This is related with the opinion stated by Vygotsky in Slavin (2011), the existence of collaborative activities with friends accompanied by supporting tools (learning media) will be easier for students to understand a phenomenon, solve problems, remember and be meaningful. STEM learning conducted by researchers is related with that opinion because in this learning, students are demanded in groups and make a teaching aid used in learning activities, it makes student learning outcomes increase. The increase in learning outcomes is also telated with the students' responses in STEM learning on aspects of students' responses to STEM-based learning in class VIII-A gets an average percentage of 95% with a very strong category, and in class VIII-B gets an average percentage of 92% with a very strong category. This is also in line with the results of the learning implementation observations. The mode value always increase in every meetings, A class got modus score 3, 4 and 4 in every meetings. It obtained from the observer's assessment results. It also happens in B class.

Improving student learning outcomes is also supported by the value of student activities during learning activities, the most dominant activity is assembling tools and conducting experiments with the average percentage in class VIII-A of 43% and class VIII-B of 49%. The most dominant activities are mostly practicum activities. According to Arsyad (2007) states that direct experience can give the most powerful and most meaningful impression of an information or idea from an experience because it involves the sight senses, hearing, touch, feeling, and smell.

Based on research conducted by Muharomah (2017) states that by implementing STEM-based learning obtained the results of hypothesis testing states that the ratio of Tcount>Ttable shows significant results between the experimental class and control class where the experimental class has better learning outcomes than the control class. This shows the same results as the results of the researchers.

Assessment of student skills is done by observing from the first meeting to the third meeting in the classes. This observation is done when STEM-based learning activities are happening. Based on the average value of students' skills increases from each meeting. The average skill of students' scores in class VIII-A respectively from the first to the third meeting were 77.3, 85.0, 90.1, while in class VIII-B were 78.6, 83.0 , 89.1.

One of the challenges of a teacher is to present an education system that provides opportunities for students to connect knowledge and skills. Opportunities will not be realized if knowledge and skills are separated in learning. According to Pfeiffer & Poelmans (2013) suggested that in STEM learning skills and knowledge are used simultaneously by students. Based on these statements can be concluded that STEM learning can train students' skills. It is in accordance with the results that each student's skills meeting experiences an increase in every classes.

CONCLUSION AND SUGGESTION

Conclusion

Based on the results of the research and discussion it can be concluded that learning motivation and student learning outcomes have increased after STEM-based learning in each class. The average N-Gain value of learning motivation in each classes is 0.6 with the medium category. The average value of N-Gain in each classes is 0.7 with a high category. Increased learning motivation and student learning outcomes experienced a consistent increase in both classes

Suggestion

From the results of the research conducted, the researcher gave the following suggestions:

1. STEM-based learning is expected to be implemented by teachers who are expected to be able to increase student motivation and learning outcomes.

2. The timing of learning activities should be carried out optimally.
3. Similar follow-up studies are carried out, so improvements can be made in the implementation of STEM-based learning to improve student motivation and learning outcomes.

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